



Study on the Curriculum Construction and Teaching of Professional Mathematics in Automobile Major for “Double High Plan”

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Abstract. Under the policy of “Double High Plan”, the quality of the vocational education should be improved and developed. In automobile major, professional mathematics course is one of the most important professional basic courses for the development of students. How to design and teach the course is a valuable question to research. The curriculum framework of professional mathematics was designed by analyzing course orientation, course objectives (including social capacities, operation abilities, and developing capacities) and course framework. The course contents were designed for students’ learning by completing the projects such as typical application of professional mathematics in automobile specialty, basic operation in mathematical software, numerical analysis on characteristics of vehicle driving, analysis on mathematical model of automobile braking, and mathematical model of robot in automobile production line. The projects were designed and the 3rd project of the course was designed and listed according to the students training program. The teaching methods and evaluation of the course were designed for students to master the basic knowledge effectively.

Keyword: Curriculum construction · Teaching · Professional mathematics · Automobile major

1 Instructions

In April 2019, the Ministry of Education and the Ministry of Finance jointly issued the “opinions on the implementation of high level higher vocational schools and specialty construction plan with Chinese characteristics”. It is proposed to focus on the construction of about 50 high-level vocational schools and about 150 high-level professional groups, to build a highland for the cultivation of technical talents and a platform for the innovation of technical skills [1]. Here the high level higher vocational schools and specialty construction plan with Chinese characteristics and specialty construction plan is called “Double High Plan” in Chinese.

With the developing of the automobile industry, the complex jobs related to automobile require the workers to have more comprehensive professional knowledge and adept skills. At the same time, high level higher vocational schools with Chinese characteristics and specialty construction plan requires that the vocational education should be more improved and perfect. It is proposed in Implementation Plan of National Vocational Education Reform that vocational education should be placed in a more prominent position in educational reform innovation and economically social development. In the Implementation Plan, important development goals for vocational education are put forward, including that the vocational education and training system should be improved, the directions should be changed from pursuing the scale expansion to improving the quality of education, and so on [2].

Under the guidance of this policy, to cultivate students with high quality, the curriculum construction for teaching is top priority. How to design and teach a course is a valuable research subject for a teacher to achieve a more satisfactory effect.

2 Professional Mathematics in Automobile Specialty

Automobile industry is a comprehensive enterprise developed on the basis of many related industries and technologies. The products of many departments are used in automobile, and all kinds of processing technologies are needed from blank processing to vehicle assembly. Car parts include thousands of different parts ranging from flooring to screws. The automobile production process includes the assembly of engine, transmission, axle, car body, tires, glass, electrical appliances, car body interior parts and other small parts [3].

Professional mathematics (PM) is one of the most important courses for students' development in career designing, and it is the first professional basic course in the process of learning courses in major [4–6]. For example, automobile assembly sequence optimization is the key and difficult content in the course of “automobile manufacturing process basis”, and it is also a basic skill that the students majoring automobile must master. The problem requires students to solve it by analyzing the process requirements of color, configuration and power on the assembly line, establishing the LP model meeting 20 constraints, and solving it by related software. The algorithm also requires students to have strong understanding ability and programming ability [7–9].

For another example, the teaching fields of automobile major include sales, maintenance, design and other specific categories, many of which are similar to “cylinder diameter” and “piston stroke” closely related to the function relationship, curve trend and monotony knowledge points in higher mathematics. In this regard, teachers should stand in the perspective of automobile professional teaching, to classify and summarize some knowledge points, and combine with the teaching plan of higher mathematics. As the builder and leader of knowledge system, teachers should actively guide students to find the correct direction of learning mathematics, so that students can understand the relevant skills and application of automobile professional learning in the process of learning mathematics knowledge, and effectively improve their professional practice ability [10, 11].

The designed quality and teaching effect of Professional mathematics directly affect students to master and absorb the knowledges of professional courses in the later stage, and may even affect students' performance and career development in specific work in the future. So how to design and how to teach the course is deserved to research.

3 Curriculum Framework Construction

3.1 Course Orientation

Professional mathematics is a compulsory technical basic course for students majoring in automobile manufacturing and assembly technology.

Based on the original knowledge of higher mathematics, the course adopts the method of combining theoretical teaching with practical application, and combines with some typical cases to lead the students to learn the basic theory of automobile mathematics. Through these methods, students could be familiar with the basic operation of mathematical modeling software, improve the ability of logical reasoning and mathematical induction, and master the ability of mathematical modeling and model calculation and analysis, so as to lay a good foundation for students' subsequent professional courses.

In the course designing plan, the integration, connection and cooperation with professional courses was proposed, the connection between curriculum content and professional courses was strengthened, and practical education was highlighted. The course is not only a supplement to the previous course "higher mathematics", but also a foundation for the related mathematical knowledge in the following courses "industrial robot technology application", "vehicle assembly and debugging", "welding robot operation and operation and maintenance", "production line operation and monitoring".

Table 1 shows the technical basic courses for specialty group designed in the students training program majoring in automobile manufacturing and assembly technology [12]. It is shown that the course of Professional mathematics designed is offered in the second semester of the second academic year for students. It is an integrated course of theory and practice whose class practice teaching accounts for about 50% of the total class hours.

In the students training program, the concept of learning time was put forward for the first time. The learning time of students includes not only the length of time for students in class, but also the corresponding learning and consolidation time under the guidance of teachers after class.

For the course of Professional mathematics, the total teaching time is 32 h and total learning time is 64 h. It means that students need to complete 32 extra hours of study after class under the guidance of the teacher.

3.2 Course Objectives

Through the study of this course, students should master the basic operation of mathematical calculation and drawing software, and master the knowledge of differential and integral of one variable function, extreme value of function, data fitting, matrix, and its operation in a calculating software. Students should understand the theory of

Table 1. Technical Basic Courses for Specialty Group

	Courses	Class hours	After class hours	Learning hours	Semester
1	Engineering Graphics	64	64	128	1
2	Engineering Mechanics	64	64	128	1
3	Mechanical Design	64	96	160	2
4	Professional Mathematics	32	32	80	4
5	Electrical and Electronic Technology	64	64	128	3
6	Automobile Structure	64	96	160	3

vehicle driving dynamics, and master the method of using software to calculate the dynamic factor speed equation to solve the speed threshold. Students can understand the influence factors of vehicle braking distance, and master the method of solving the braking distance threshold by using software to calculate the braking balance equation. Students could understand the kinematics equation of robot arm in automobile manufacturing, and master the method of coordinate transformation using related software. Students can also be able to use the advanced mathematics and automobile professional knowledge to solve the related practical engineering problems, and have the ability of preliminary mathematical modeling and result analysis after learning the course. The specific objectives of the course to develop the abilities for students are shown in Fig. 1 as follows.

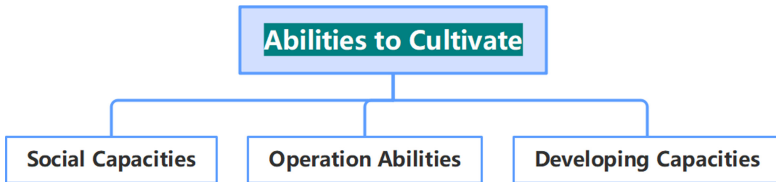


Fig. 1. The abilities to cultivate in specific objectives of professional mathematics.

Social Capacities. Our teaching design should take the following methods to help students to achieve the social capabilities. (1) Carry forward the socialist core values and establish the world outlook of dialectical materialism. (2) Establish the ideal and belief of innovation, cultivate the craftsman spirit and the professional spirit of continuous improvement, and cultivate the students’ sense of responsibility, self-discipline and the

spirit of hardship. (3) Enhance students' executive ability and communication ability, and cultivate students' team cooperation ability. (4) Cultivate students' ability of self-study, literature review and summary, and improve their ability of using mathematical knowledge to analyze and solve practical problems.

Operation Abilities. Our teaching design should take the following methods to help students to develop students' operation skills. (1) Understand the basic concept of function, master the commonly used dynamic calculation and analysis methods, so as to solve the problems of vehicle power calculation and performance factor analysis, to improve the ability of solving problems. (2) Be proficient in curve fitting of discrete points with the software. (3) Master the concept of derivative and extremum in mathematics, be able to solve the calculation problems in vehicle motion and braking by combining kinematics and dynamics theory and using relevant mathematical knowledge. (4) Master the basic concepts of array and matrix, master the contents of linear equations and related matrix transformation, and skillfully use software to calculate matrix. (5) Be able to apply the knowledge of matrix analysis to solve the problems of industrial robot motion and its positive and negative solutions. (6) Master the basic operation of the related mathematical software, be able to use software to establish the mathematical model of automobile driving, braking and robot kinematics of automobile production line, and carry out simulation calculation. (7) Be able to analyze the mathematical logic of the research object and its influencing factors based on the results of simulation calculation.

Developing Capacities. The teaching design should help students to achieve the developing capabilities which are designed to include logical reasoning ability, analysis ability and preliminary mathematical modeling ability.

Logical Reasoning Ability. Facing to the problems in the processing of learning, students can use the achieved knowledge to analyze reasoning related problems and get mathematical laws for solving the kind of problems.

Analysis Ability. Students could be able to calculate with related software and analyze the results of the calculations. For example, for automobile, the steel panel part will deform after being stressed. By modeling, the deformation will be calculated and displayed in the software to help students to analyze the forces and materials being stressed. Figure 2 shows the deformation in the example.

Mathematical Modeling Ability. After analyzing on the problem, by mathematical modeling software, students could master the relationship between the objects and the mathematical models. For example, the plot drawing with software was taken into the teaching to help students to establish mathematical models. Fig. 3 and Fig. 4 show the plot models for students' practicing.

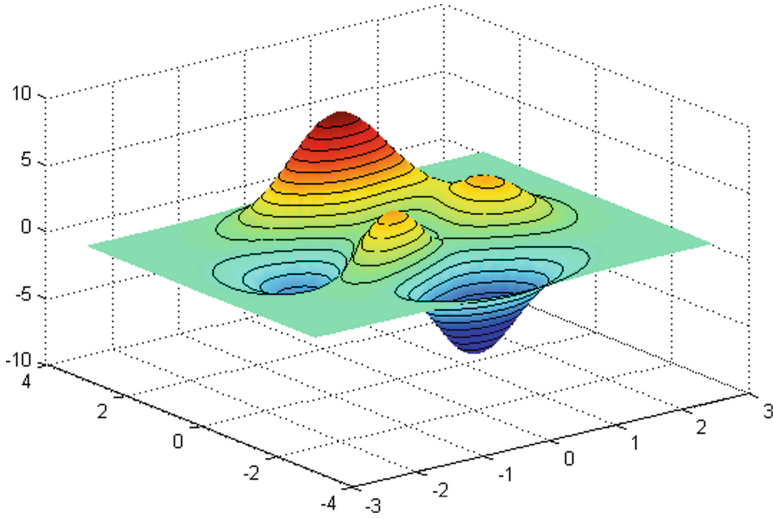


Fig. 2. Deformation model and analysis in professional mathematics.

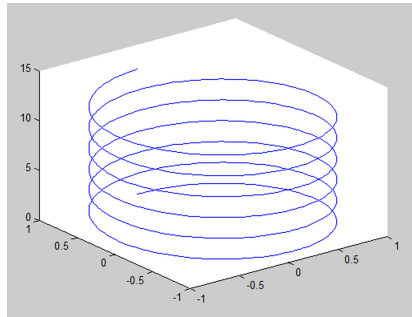


Fig. 3. A drawing example in professional mathematics.

4 Course Contents Design

4.1 Modular Projects Design

Based on the study and supplement of advanced mathematics and applied mathematics, combined with the automobile assembly and manufacturing technology related majors, mathematical calculation software was applied to design the relevant mathematical models and calculation problems of automobile in driving, braking, production and other projects. Students could solve the related problems in the automobile industry through learning mathematical knowledge, building models and software calculation. These problems were summarized into several kinds of related modular projects shown in Fig. 5.

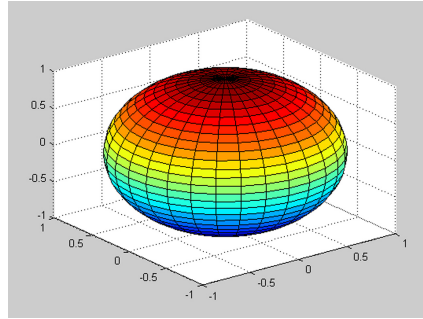


Fig. 4. The plot drawing in professional mathematics.

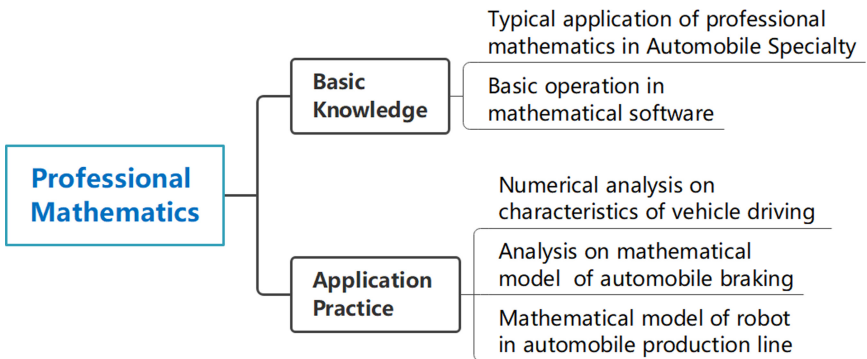


Fig. 5. Modular projects designed in professional mathematics.

4.2 Course Contents Design

The course contents were designed and summarized into five modular projects including typical application of professional mathematics in automobile specialty, basic operation in mathematical software, numerical analysis on characteristics of vehicle driving, analysis on mathematical model of automobile braking, and mathematical model of robot in automobile production line. For example, the specific contents of 3rd part of projects are designed and shown in Table 2.

Table 2. The specific contents of the 3rd project designed.

Projects	Learning models	Contents	Teaching standards	Teaching methods	Evaluation content	Learning hours
3. Numerical analysis on characteristics of vehicle driving	In Class	<ol style="list-style-type: none"> 1. Interpolation and fitting 2. Motion analysis in the process of driving 3. Vehicle power analysis and modeling 	<ol style="list-style-type: none"> 1. Master the knowledge of interpolation and fitting, and be able to fit the curve according to the given data 2. Understand and analyze the motion problems in the process of driving 3. Understand vehicle power problems and be able to establish relevant mathematical models 	<ol style="list-style-type: none"> 1. Demonstrate the operation method 2. Group discussion 3. Heuristic guidance 	<ol style="list-style-type: none"> 1. Attendance and answering questions in class 2. Class notes and exercises in class 3. Case analysis 	6

(continued)

Table 2. (continued)

Projects	Learning models	Contents	Teaching standards	Teaching methods	Evaluation content	Learning hours
	After Class	<ol style="list-style-type: none"> 1. Interpolation and fitting exercises 2. Consult materials to understand and summarize the problems of motion and power in driving 3. Case analysis, using MATLAB software to model and analyze the problem 	<ol style="list-style-type: none"> 1. Be able to use interpolation and fitting knowledge to solve problems 2. Be able to use MATLAB software to analyze and calculate relevant models 	<ol style="list-style-type: none"> 1. self-directed learning 2. Group discussion 3. Practice the problem driven method 	<ol style="list-style-type: none"> 1. Study notes 2. Group discussion 3. Research Report or professional mathematics essay 	9

5 Teaching and Evaluation

5.1 Teaching Methods and Devices

The teaching mode of professional mathematics course should highlight students' subjectivity, strengthen the interaction between students in teaching activities, and mobilize students' learning enthusiasm to the maximum extent. Affirm the progress of students in learning in time, strengthen the role of motivation, so that students can establish self-confidence. At the same time, we should pay attention to the trinity of knowledge, ability and attitude.

Teaching Methods. In terms of teaching methods, case driven, demonstration and group learning are the main methods. Combining mathematical knowledge and specialty, using mathematical modeling to deal with professional problems, the importance of the course was stated, so as to stimulate students' enthusiasm for knowledge, and mobilizes students' subjective initiative. In the teaching mode, we should reduce and prevent the simple explanation teaching, emphasize the students as the main body, give students more space for practical activities, actively carry out the interaction and multimedia teaching suitable for students, and make full use of the network resource platform. We should establish a new teaching mode of "taking learning as the center, taking students as the main body and teachers as the leading role", and pay attention to the Trinity training of knowledge, ability and quality in teaching objectives.

Teaching Devices. In classroom teaching, students should complete the project through learning. Multimedia teaching and broadcasting system, multimedia teaching website, network classroom, animation demonstration and other auxiliary teaching methods are adopted. The most time in class should be spent on students' completing the projects on their own initiatives. Its rich and diverse information bearing forms, flexible and convenient interactive features, which is easy for students to understand and master, increase students' interest in the course. When operating on the computer, software is necessary to train students to establish and analyze the mathematical model of the relevant problems encountered in professional learning.

5.2 Evaluation

"N + 2" evaluation pattern is adopted. The evaluation system includes mid-term test (10%), summary report (15%), case analysis report (15%), special research report (10%), Notes (10%) and module end test (40%), which is shown in Fig. 6.

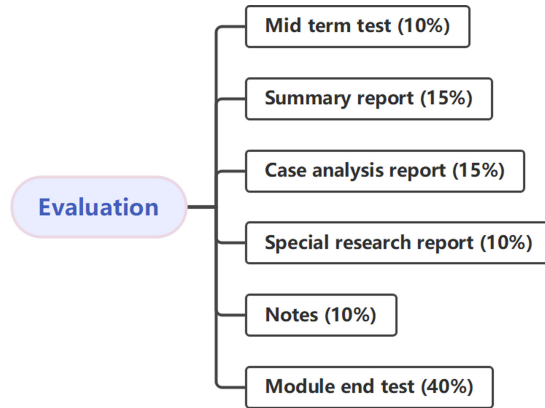


Fig. 6. Evaluation system.

6 Summary

Professional mathematics is an important basic course for students majoring in automobile. The framework of professional mathematics was designed by analyzing course orientation, course objectives (including social capacities, operation abilities, and developing capacities), and course framework. The course contents were designed into five projects whose contents and teaching methods were designed. The 3rd project of the course was shown in paper. The teaching methods and evaluation of the course were designed for students to master the basic knowledge effectively. The constructions of the curriculums under the background of the “Double High Plan” will push the development of vocational education in China forward.

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